

Medical response to a natural disaster: the Barrie tornado

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On May 31, 1985, a tornado devastated an area of Barrie, Ont. Following a prepared disaster plan, the staff of the local hospital managed 155 casualties, including 16 cases of multiple trauma, over 5 hours. The authors summarize the hospital's experience and give recommendations to help the staff of other hospitals improve their disaster plans.

Quand une tornade s'abat sur un quartier de la ville de Barrie (Ont.) le 31 mai 1985, on met aussitôt en branle un plan d'action pré-établi en cas de désastre. En l'espace de 5 heures, l'hôpital local traite 155 blessés dont 16 personnes polytraumatisées. Les auteurs résument ce qui s'est passé alors et formulent des conseils à l'adresse des autres hôpitaux qui voudraient améliorer leurs plans d'action.

Barrie is a quiet city of 45 000 in "cottage country" 80 km north of Toronto. It was quiet until the afternoon of May 31, 1985, when a tornado swept through the Allandale section of the city. The medical response to this disaster was centred in Royal Victoria Hospital (the only hospital in the city), a 350-bed general hospital with a well equipped intensive care unit and a new surgical day-care unit integrated with the Emergency Department. There are 115 physicians on active staff, representing every surgical subspecialty except thoracic surgery and neurosurgery. The main referral centre for Barrie is Toronto.

Barrie had not previously experienced any natural disasters, although physicians in the Emergency Department frequently deal with cases of multiple trauma as a result of motor vehicle accidents. In the summer of 1984 the hospital was the scene of intensive disaster preparations. A hot-air balloon contest in Barrie was expected to draw 250 000 visitors for a week in July, and a crowd of 500 000 had been predicted for the visit of Pope John Paul II to Midland, Ont. (50 km away) in August. Neither event attracted the expected numbers or caused any increase in visits to the

Emergency Department. The preparations, however, did prove useful after the tornado.

The Barrie tornado

A tornado is "an intense rotatory storm of small diameter characterized by at least one vortex reaching the earth's surface from a thunderstorm".¹ Although uncommon in Canada, these violent storms have been extensively studied and catalogued. Between 1950 and 1979 there were an average of 21 tornadoes a year across Canada, of which 14 occurred in Ontario and Quebec. The highest-risk zone in the country is the area around Windsor, in southwestern Ontario, with an area of slightly lower risk extending east to Toronto. The peak of tornado activity is in late June and early July, and the peak time is from 3 to 7 pm.¹

The tornado activity in southern Ontario on May 31, 1985, was the most severe in 30 years and the third worst in Canadian history.² (The two worst tornadoes were in Regina in 1912, with 28 deaths, and in Windsor, Ont., in 1946, with 16 deaths.) There were nine tornadoes in Ontario on May 31; seven caused little damage. The tornado in the Grand Valley-Tottenham area, which travelled 90 km and killed four people, was graded 4 on the Fujita scale,³ an internationally used scale for estimating the strength of a tornado; it ranges from 0 to 5.

The tornado that hit Barrie, graded 4 on the scale, started in Hopeville, Ont., and travelled 85 km before disappearing over Lake Simcoe. Within the city limits of Barrie the tornado's track varied in width from 50 to 600 m and was 5 km long. The winds were estimated at 400 km/h. Sixteen factories were heavily damaged or destroyed. Cars were blown hundreds of metres; 35 sailboats, along with their concrete anchors, disappeared from a marina.³ A total of 605 houses were severely damaged, of which 265 were rendered uninhabitable.

It had been a usual day at the hospital until the power failed, at 4:30 pm. There were just a few physicians in the hospital at 5:05 pm, when an injured man walked into the Emergency Department and announced: "A tornado has flattened Allandale." The disaster plan was immediately put into effect by a surgeon who happened to be in the department. A serious problem then arose: as the switchboard operators started the "fan-out" calls,

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they found many of their outgoing lines inoperative. However, many of the hospital and medical staff arrived without being notified because they had seen the tornado or heard the sirens.

The chronology of events is shown in Table I, and the types of injury seen are shown in Table II. During the 4 busiest hours most of the injured people came to the hospital in private cars; however, ambulances brought most of the more seriously injured. Triage was performed at the entrance to the Emergency Department by the surgeon who had implemented the plan. Patients who required immediate care were sent to the emergency department, where there were four teams, each consisting of an internist, a surgeon and a general practitioner or emergency physician; the teams worked in separate resuscitation rooms. The less seriously injured patients were sent to the cafeteria, where most of the suturing was performed.

While the disaster plan was in effect, we were working at the limit of our capacity. The Emergency Department had 4 minor operating rooms, 10 assessment beds and 8 more beds in the adjacent surgical day-care unit. By 6 pm there were 20 physicians and 30 nurses in the department attending to 40 patients, many of whom were critically injured.

The disaster plan called for the quick discharge of all inpatients who could manage at home; 38 such patients were discharged. Three visitors to Barrie were transferred to hospitals in their hometown, and 10 patients were referred to Toronto hospitals (Table III). Of the 21 patients admitted to our hospital 11 were discharged the next day. The remaining 10 accounted for 100 hospital days. The eight deaths were all attributed to massive crush injuries to the head and chest. No autopsies were performed.

Discussion

The epidemiologic features of tornadoes have been studied by various investigators,⁴⁻⁸ several of whom have looked specifically at the injuries suffered in tornadoes and have found that soft-tissue injuries (especially contaminated lacerations) are very common, and head injuries and fractures are the commonest serious injuries.⁴⁻⁷ Our experience was similar.

The location of people when they are injured is also of interest. Glass and colleagues⁴ estimated that the relative risk of serious or fatal injury is 3/1000 for people who are indoors when the tornado strikes, 23/1000 for those in cars and 85/1000 for those in mobile homes. Unfortunately, comparable data for the tornado in Barrie are not available.

Stewart⁷ carried out an in-depth analysis of the emotional health of 37 families whose homes were destroyed in a tornado in 1979 in Woodstock, Ont. She found a high level of psychologic distress that took up to 8 months to subside, with males tending to require medical services more in the

second 3-month period after the tornado than at other times. As well, she found evidence of an "anniversary syndrome", especially among children. On the basis of this information, our county health unit set up a counselling referral service in the weeks after the tornado, which attended to 350 requests for help over 4 months. In addition, many patients received advice and counselling from their physicians.

Other authors have stressed the importance of on-site stabilization and triage in disaster training and planning.^{9,10} However, the triage team that went out from our hospital found no one main disaster site. As well, Mandelbaum and associates⁵ observed that the injured arrive at the hospital in no particular order; often the less seriously injured walk in first, while those with critical injuries may need to be extricated before being taken to hospital.

Our organized medical resources were fortunately able to handle the disaster — the hospital

Table I—Chronology of events at Royal Victoria Hospital, Barrie, Ont., during tornado

Time (pm)	Event
4:30	Power failure; emergency generators took over
5:00	Tornado touched down
5:05	First injured person arrived; disaster plan implemented
5:15	Injured people started to arrive steadily
5:30	35 physicians working; Emergency Department full of patients
6:00	50 physicians working in Emergency Department, operating rooms and cafeteria
9:30	A few injured people still arriving; medical staff started to go home
11:30	Disaster plan called off

Table II—Types of injury seen*

Injury	No. of patients
Multiple trauma	16
Head injury	16
Fracture	10
Laceration	75
Soft-tissue injury	38
Total	155

*Each patient is classified by the most severe injury.

Table III—Admission status of patients

Status	No. of patients
Dead on arrival or died in Emergency Department	7
Transferred	
To Toronto hospitals	10*
To local hospitals	3
Admitted to our hospital	21
Treated and released	114

*One died in a Toronto hospital.

was untouched, none of the medical staff were injured, and outside help arrived within hours. During the 4 busiest hours our staff cared for 34 patients with injuries severe enough to necessitate admission to hospital. This number corresponds with the expectation that an average district hospital of 300 beds can cope with six to nine critically injured patients per hour.¹¹

Recommendations

The importance of a regularly updated and rehearsed disaster plan cannot be overemphasized.¹⁰ There is no doubt that the preparations in the summer of 1984 helped the physicians in Barrie manage the casualties of the tornado. We offer the following recommendations for preparing a disaster plan.

- The plan should be individualized for each hospital, taking into account local physical and human resources and local risks, such as earthquake zones, nuclear power plants and chemical factories. As well, allowance must be made for damage to the hospital.

- Emergency physicians should consider taking training in disaster management,¹² such as the 16-hour course prepared by the American College of Emergency Physicians.⁹

- A standard triage code for incoming casualties is necessary. Research tools such as the Abbreviated Injury Scale or the Injury Severity Score¹³ are too complicated for quick use. Gerace¹⁰ has suggested using coloured tags: pink for priority 1 (life-threatening injuries), blue for priority 2 (serious injuries) and yellow for priority 3 (minor injuries). Unfortunately, the Ontario ambulance system has for years used a different system: priority 4 means life-threatening illness, and priority 1, minor injury. This is a potential source of serious misunderstanding.

- Related to triage are the problems of patient flow within the hospital and allocation of medical staff. It may be most effective to have separate areas for treating injuries of various priorities, with specific physicians assigned to each area by the triage officer. For instance, emergentologists and general surgeons could attend to priority 1 cases in the emergency department trauma rooms while priority 2 cases are treated in the "back rooms" of the department by specific surgeons assisted by family physicians. Priority 3 cases should be treated in a separate area of the hospital (e.g., cafeteria, waiting room or other large areas) by family physicians, possibly with a surgeon overseeing. Services provided by other departments, such as radiology, laboratory and blood bank, should be devoted solely to priority 1 patients until they are all stabilized, then provided to priority 2 patients and only thereafter provided to priority 3 patients.

- Lack of communication between the disaster site, ambulance dispatch centre, hospital and other centres, such as the fire and police depart-

ments, can be a serious problem. During the tornado in Barrie, telephone lines were down and the power was out, and communication was virtually nonexistent. Gerace¹⁰ has suggested using hand-held police radio units, ambulance dispatch radios and mobile radio units to ensure adequate communication. In Ontario there is now a radio frequency that is used only in a disaster by ambulance staff and fire and police departments.

- Identification of staff, especially key members, is important. This can be done with colour-coded hard hats labelled with titles, such as "triage coordinator",¹⁰ for the on-site triage team. One small problem in Barrie was that police roadblocks went up so quickly and were so carefully guarded that some medical staff had trouble getting through to the hospital.

Conclusion

The tornado in Barrie was a major disaster that necessitated the involvement of all the resources of the local hospital. The events not only proved the worth of the established disaster plan but also led to major changes in the plan. We urge the staff of other hospitals to re-examine their disaster plans.

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